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Different Principles for defining selectivity under the future TM regulation (STECF-13-04)

Edited by Norman Graham & Hendrik Doerner

This report was reviewed by the STECF during its 42nd plenary meeting held from 8 to 12 April 2013 in Brussels, Belgium

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Different Principles for defining selectivity under the future TM regulation (STECF-13-04)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS, BELGIUM, 8-12 APRIL 2013

Background

An integral part of nearly all fisheries management frameworks has been the regulation of technical aspects of fishing operations, through so-called technical measures. These define where, when and how a fishing enterprise exploits commercial fish resources and interacts with the wider marine ecosystem.

Technical measures have been used extensively in EU fisheries since the adoption of the Common Fisheries Policy (CFP) in 1983. Despite the 'growth' in technical measures, there is a commonly held belief that technical measures as implemented in the EU have failed to deliver the desired level of protection for juveniles and reductions in unwanted by-catch.

Recognising this, as part of the on-going reform of the CFP, the Commission has signalled its intention to develop a new approach to regulate technical measures based on simplification, adaptation of decision making to the Lisbon Treaty, increased regionalisation, greater stakeholder involvement and more industry responsibility. This approach will strengthen conservation and resource management through better selectivity and better protection of the environment. It is centred on the development of an overarching technical measures framework with specific regionalised measures included under multiannual plans.

The purpose of this EWG is to explore the potential of technical measures as a management tool in the context of a reformed CFP, taking account of the frequently reported problems with the current technical measures contained in EU law. The EWG were tasked to explore the overarching principals of technical measures in the context of the current CFP and its ongoing reform. It is not the intention to provide a detailed roadmap of which technical measures should be deployed in the future; this will require further work which can only be undertaken once further clarity on the content of the final CFP agreed.

Request to the STECF

STECF is requested to review the report of the STECF Expert Working Group meeting (EWG 13-01), evaluate the findings and make any appropriate comments and recommendations.

STECF observations and conclusions

The regulation of technical aspects of fishing operations, through so-called technical measures regulations, defines where, when and how a fishing enterprise exploits and interacts with marine resources and the wider marine ecosystem. Technical regulations can be loosely grouped into those that regulate the design characteristics of the gears that are deployed such as the regulation of mesh size; those that regulate the operation of the gear such as setting maximum limits on how long or what type of gear can be deployed; those that set spatial and temporal controls such as closed/limited entry areas and seasonal closures; and those that define minimum sizes of fish and specify catch composition. Technical measures largely aimed to reduce catches of juveniles of commercial and non-commercial species, to improve species selectivity, to avoid catches of protected species, to reduce discards and minimize the impacts on the environment.

The main objective of the working group was to address the use of technical measures in the context of results-based management (RBM). In that context, it is important to note that in the report "technical measures" means technical tools such as gear characteristics, restricted areas, size of fish and "technical regulations" refers to technical measures prescribed in EU regulations.

In addition to the possible results-based management of the toolbox of technical measures, the EWG reviewed the tactical objectives of technical measures. The report highlights that technical measures will have an impact on the exploitation pattern which in turn may affect the estimated F_{MSY} and associated fishing opportunities. STECF considers that the linkage between selectivity and catch should be part of the advice on fishing opportunities. This would have the benefit of giving a transparent association between improving selectivity and improved fishing opportunities thereby creating a possible incentive to improve selectivity. Thus far such linkages have been absent from catch forecasts and technical measures have tended to be treated externally to the setting of fishing opportunities.

STECF considers that the EWG 13-01 has appropriately addressed the TOR and STECF endorses the report of the expert group. STECF furthermore considers that the report of the EWG 13-01 forms a good basis for the Commission to proceed with the development for a proposal for a new regulation on technical measures.

Predicting Fishing opportunities; consequences of changes in technical measures

STECF considers that in the context of the transition period to the FMSY management objective, the link between selectivity and management thresholds should be systematically investigated. Estimating FMSY and fishing opportunities according to various management options related to technical measures would substantially improve the advice, providing new insights into fisheries management. STECF also notes that in cases where changing the selectivity or introducing new technical measure will in the long-term, lead to changes in catch or stock biomass, the transition periods should be investigated, with particular attention being given to analysing the potential economic consequences of such changes in the short-term and possible changes in fishers' behaviour (shift in areas, target species, etc.). The direct and indirect ecosystem impacts of changing exploitation patterns should also be considered.

REPORT TO THE STECF

EXPERT WORKING GROUP ON
Different Principles for defining selectivity under the future TM regulation (EWG-13-01)

Dublin, Ireland, 4-8 March 2013

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1 EXECUTIVE SUMMARY

Under the current CFP it is considered that technical measures should ensure the protection of marine biological resources and the balanced exploitation of fishery resources in the interests of fishermen and consumers. Inter alia, this should include "reducing the capture of juveniles of marine organisms through mesh size and catch composition rules; protecting nursery and spawning areas taking into account the specific biological conditions in the various zones concerned; establishing a balance between adapting technical conservation measures to the diversity of the fishery; homogeneous rules which are easy to apply; and integrating environmental protection requirements with technical measures notably in the light of the precautionary principle.

In 2012 an STECF Expert Working Group was formed to assist in the development of this proposal. EWG 12-14 met in October 2012 and explored the potential of technical measures as a management tool in the context of the reform of the Common Fisheries Policy (CFP) and also began to investigate possible new approaches to regulating technical measures in the context of a reformed CFP

EWG-12-14 concluded that "In general TM relating to gear selectivity have no clearly defined objective and, following the EU decision-making process, the measures finally adopted often differ from what was initially proposed and tested. Many measures are adopted just to improve selectivity.

To continue the work of EWG 12-14 it was decided at the STECF plenary meeting of November 2012 to form a second EWG, -EWG-13-01- to look at a number of important issues that were not dealt with by EWG 12-14.

EWG-13-01 was asked to identify "identify tactical objectives that could potentially be achieved using technical measures in the context of results based management". EWG-13-01 noted that technical measures offer an objective means to affect several aspects on the interaction between fishing activity on exploited marine organisms and the broader marine environment. This includes; affecting the distribution of fishing pressure; affecting the impact of fishing on both the physical and ecological environment; and providing an objective mechanism of defining fleet management units based on their gear type and selectivity.

In terms of fishing pressure, technical measures can affect both exploitation pattern (EP) i.e. the distribution of fishing pressure across the demographic (age) spectrum of a given stock and secondly affect the overall exploitation rate through the deployment of species selective gears which avoid the capture of specific species in a given gear. Therefore, and in the context of the overarching objectives of the new CFP, technical measures can contribute to the attainment of F_{msy} objectives through either mechanism. Scott and Sampson (2011) note that the exploitation pattern has a significant influence on the point estimates of Fmsy for a given exploitation rate and in general a higher exploitation pattern results in a higher Fmsy yield. Therefore, technical measures: through adjustments in gear design and operation as well as spatial and temporal controls can contribute significantly to changes in exploitation pattern and therefore changes in the potential yield that can be removed from a stock due to changes in F_{msy} exploitation rates.

To date, gear related technical measures have been viewed by fishermen as means to apply further restrictions on their activity by adding further restrictions which result in additional losses in revenue through direct (loss of fish) and indirect means (cost of gear replacement) and have tended to be partially mitigated through technical innovation. This not only dilutes the intention of the measure, but directs the innovative potential of the fishing industry away from the development and deployment of fishing techniques that have the potential to improve the yield from the stock towards the maintenance of the status quo, sub-optimal harvesting strategy.

Generally, the effects on fisheries of technical measures alone cannot be disentangled from the effects of other management tools implemented simultaneously, such as TACs and fishing effort restrictions. There is a lack of clear objectives for most technical measures and simultaneous application of other input and output controls only allows a comparison of the package of measures taken with the outcomes observed. In practice, it is not usually possible to quantify the extent that observed outcomes are attributable to one or other of the measures in place. Furthermore, the introduction technical measures, with the exception of the Long Terms Management Plan for Cod (Regulation (EC) No 1342/2008) have not resulted additional fishing opportunities for the fleets concerned, but have rather been implemented to achieve some undefined objective which has or at least perceived to result in some loss of catch and their introduction is done through the risk of punishment rather than benefit. No doubt, this has been a key driver in the failure of technical measures to deliver their intended stock benefits.

The ‘new’ CFP aims towards a regionalised approach with a greater participatory structure where stakeholders have a greater influence in terms of how the overarching CFP objectives (F_{msy}) are achieved. Recognising that technical measures can have a significant bearing on the F_{msy} yield that can be achieved from a given stock, EWG-13-01 considers that it is worth exploring how technical measures (gear/spatial/temporal) as drivers for changes in exploitation pattern can be formally integrated into multiannual management plans, along with existing measures e.g. TACs, whereby positive adjustments in EP could result in increased fishing opportunities. This could potentially be achieved by directly linking exploitation pattern and yield through a harvest control rule type approach, where the F_{msy} is routinely recalculated to consider changes in selection pattern. To date, HCR’s simply function as a result of the size of the spawning stock and a fixed fishing mortality rate. In the context of technical measures and their influence on the exploitation pattern and therefore impact on the estimate of F_{msy}, introducing exploitation pattern as a multiplier would have the benefit of directly linking the TAC with the selectivity of the fleets exploiting that stock. This would have the benefit of giving a transparent association between improving selectivity and improved fishing opportunities thereby creating an obvious incentive to improve selectivity. Thus far such linkages have been absent from catch forecasts and technical measures have tended to be treated externally to the setting of fishing opportunities. Internalising changes in EP in terms of changes in potential yield provides a real commodity to incentivise change through a conservation credit approach. Such an approach also has the advantage of providing flexibility in how such changes in exploitation pattern are achieved and encourages technical and tactical innovation.

In relation to the application of technical measures in reducing the impacts of fishing on both the physical and ecological environment in the future CFP, EWG 13-01 considered the requirements of the MSFD and NATURA 2000 and concluded that the following are relevant

- recovering and maintaining the conservation status of ‘features of conservation interest’ (foci) and species identified under the Birds and Habitats regulations;
- maintaining biological diversity;
- maintaining populations of all commercially exploited fish and shellfish within safe biological limits;
- ensuring that all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity; and
- recovering and maintaining sea-floor integrity at levels that ensure that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

Concerning the achievement of Good Environmental Status (GES) under the MSFD the majority of Member States seem to acknowledge that the reformed CFP is the mechanism for providing a robust framework for the sustainable management of marine biological resources and ensuring a level playing field in Community waters. The kinds of measures which are most likely to achieve this include technical measures that improve gear selectivity, eliminate discards, spatial/temporal restrictions and output measures e.g. catch or landings limits. All of these are already in place across our fisheries in some shape or format. They have been evaluated by statutory conservation advisors to MS governments.

Managing fleet units based on homogenous characteristics is an important component of mixed-fisheries and fleet based management. The movement towards such approaches, where advice is focussed at the level of the fleet or fishery rather than the stock, requires the establishment of management units (fleets) which can be defined based on homogeneity of vessel and gear characteristics. To this end, technical specifications of the gears and mesh sizes used by different fleets are commonly used as part of fleet definitions. Technical regulations (mesh size and gear type) by default define the fleet 'bin' that an individual vessel belongs to at a given time, so the gear characteristics in themselves are not management instruments per se, only descriptors. Under the current regulatory system, the permissible mesh size is defined by the retained catch composition and area of operation. This raises two issues for consideration.

Firstly, the level of aggregation is a compromise between maintaining some degree of homogenity with respects to the stocks/size groups captured and the broader effects on the environment.. The second, more fundamental issue relates to the continued use of mesh size to define a specific fleet given a more results driven approach to management may be more effective and appropriate (as concluded by EWG 12-14). If fully effective, one of the consequences of an RBM is that there would be no need for technical regulations and this would mean that one of the key fleet (input) descriptors would be removed. Therefore, alternative input based metrics would be required for defining fleet units or mesh size regulation could simply become a contributing feature for defining fleet units with no specific objective related to the catch.

A switch towards results based approach, away from the current prescriptive technical definitions of permissible gears, has often been cited as a preferable approach. Instead of complex legal definitions, which are often difficult to regulate and enforce, it may be more appropriate to focus on the result i.e. a specified catch profile. In the context of a discard ban or fully documented fisheries, it could be foreseen that the need for technical regulations would be minimal as businesses would evolve to minimise unsalable catches and focus their exploitation patterns towards catch compositions that are economically optimal. However, this is dependent on the assumption that the optimal economic catch profile is consistent with the biological or ecological optimum. With regards to the discard ban as the basis to 'de-regulate' the current approach to technical measures, this is critically dependent on the degree of compliance. Failure to acknowledge implementation issues associated with the discard ban is likely to result negative unintended consequences due to free-rider effects unless the ban is adequately controlled and enforced.

Replacing technical specifications with catch based targets would allow freedom within the industry to choose the most appropriate tools to their business to achieve the specific targets. This has many advantages; freedom to select is likely to provide a strong motivational response from the industry and will encourage motivation towards the attainment of quantifiable goals. However, such an approach is dependent on understanding of the goals at an individual business level and goal setting that is achievable. Setting minimum catches of size classes or species could possibly provide understandable targets and these could be readily linked to overall stock objectives, e.g. desired exploitation pattern by age. However, given within and between stock dynamics, it is difficult to identify stable and specific metrics that are not susceptible to inter annual changes in population(s) structure over time and therefore catch based metrics are likely to stock and regionally specific and subject to ongoing revaluation. Alternatively, it may be desirable to specify minimum selectivity standards e.g. species specific L50 targets, and then to allow freedom for the industry to determine the specific gear characteristics required to achieve this. However, this requires industry/science collaboration to evaluate alternative means and will ultimately result in the need for a range of permitted gears due to control and monitoring requirements.

2 INTRODUCTION

An integral part of most fisheries management frameworks has been the regulation of technical aspects of fishing operations, through so-called technical measures. These define where, when and how a fishing enterprise exploits commercial fish resources and interacts with the wider marine ecosystem. Technical measures have been used extensively in EU fisheries since the adoption of the Common Fisheries Policy (CFP) in 1983. Despite the 'growth' in technical measures, there is a commonly held belief that technical measures as implemented in the EU have failed to deliver the desired level of protection for juveniles and reductions in unwanted by-catch.

As part of the discussion of the reform of the Common Fisheries Policy (CFP), the shortcomings of technical measures have been highlighted. This has led to a political commitment being given by the Commission to come forward with a new proposal for technical measures post-reform. In 2012 an STECF Expert Working Group was formed to assist in the development of this proposal. EWG 12-14 met in October 2012 and explored the potential of technical measures as a management tool in the context of the reform of the Common Fisheries Policy (CFP) and also began to investigate possible new approaches to regulating technical measures in the context of a reformed CFP. EWG 12-14 discussed the historic effectiveness of technical measures; considered the future objectives of gear based technical measures in relation to overarching management objectives under the CFP and environmental legislation; reviewed management approaches for technical measures and how these affect uptake and application of selective gears; and explored how technical measures could be regionalised within the context of the management strategies considered and how such regionalised measures can be evaluated.

EWG 12-14 identified a number of serious deficiencies in technical measures. Of particular note is that in general, technical measures have been introduced without specific objectives making any formal evaluation problematic. While no formal, quantitative assessment is possible, given the continued high levels of discards associated with many European fisheries, it is apparent that anticipated impacts of technical measures have not been fully realised due to inability or unwillingness to deploy as intended and control and enforcement difficulties. The measures finally adopted have also often differed from what was initially proposed and tested. Many measures are adopted just to improve selectivity but without specified goals with which we can assess the degree of improvement. Additionally technical measures have tended to be implemented through negative incentives and the prescriptive nature of the regulations have also stifled positive technical innovation by the industry i.e. fishermen have used their ingenuity to circumvent the regulations rather than develop technical solutions to specific conservation problems. It has also been shown that the utility and effectiveness of technical measures is heavily dependent on the regulatory framework in which they are deployed and whether the approach promotes the use of technical measures through incentives. However, EWG 12-14 concluded that despite these deficiencies in controlling exploitation pattern, the use of technical measures does have a significant role in terms of conservation benefit (e.g. In the context of reaching F_{msy} it may be possible to identify target exploitation patterns and to monitor the performance of the fleets/metiers in attaining these goals), while technical measures also have an important role in terms of wider ecosystem considerations.

EWG 12-14 also considered a number of significant changes to the management system proposed under the reform of the CFP (COM, 2011) which will impact on the future of technical measures. These include an obligation to land all catches (discard ban) and a move towards a more regionalised approach through multi-annual plans which cover multiple stocks where and when they are exploited together. This will result in a significant paradigm shift from current management approaches. Figure 2.1 shows how in the future policy landscape, technical measures will shift from the current paternalistic position (red box) to one where they will be integrated directly into management plans and form one of the instruments available to managers to attain sustainable exploitation of marine resources. The broad policy objectives e.g F_{msy} and ecosystem objectives will be set at European level

(DG MARE) and the choice of instruments taken by regional authorities in consultation with stakeholders. The purpose of regionalisation in this sense, is twofold: moving away from micromanagement at Union level, and ensuring that rules are adapted to the specificities of each fishery and sea basin. It is envisaged that this will lead to and promote increased regional cooperation in the development of multiannual plans and specific plans for the implementation of the obligation to land all catches as well as for environmental policy objectives. This provides a challenge to the Regional Advisory Councils (RACs) and managers to identify and apply instruments that are consistent with the overall policy objectives whilst maximising the potential yield available and avoiding TAC/quota overshoots. These policy shifts will likely lead to increased focus on the use of technical measures to attain these policy objectives.

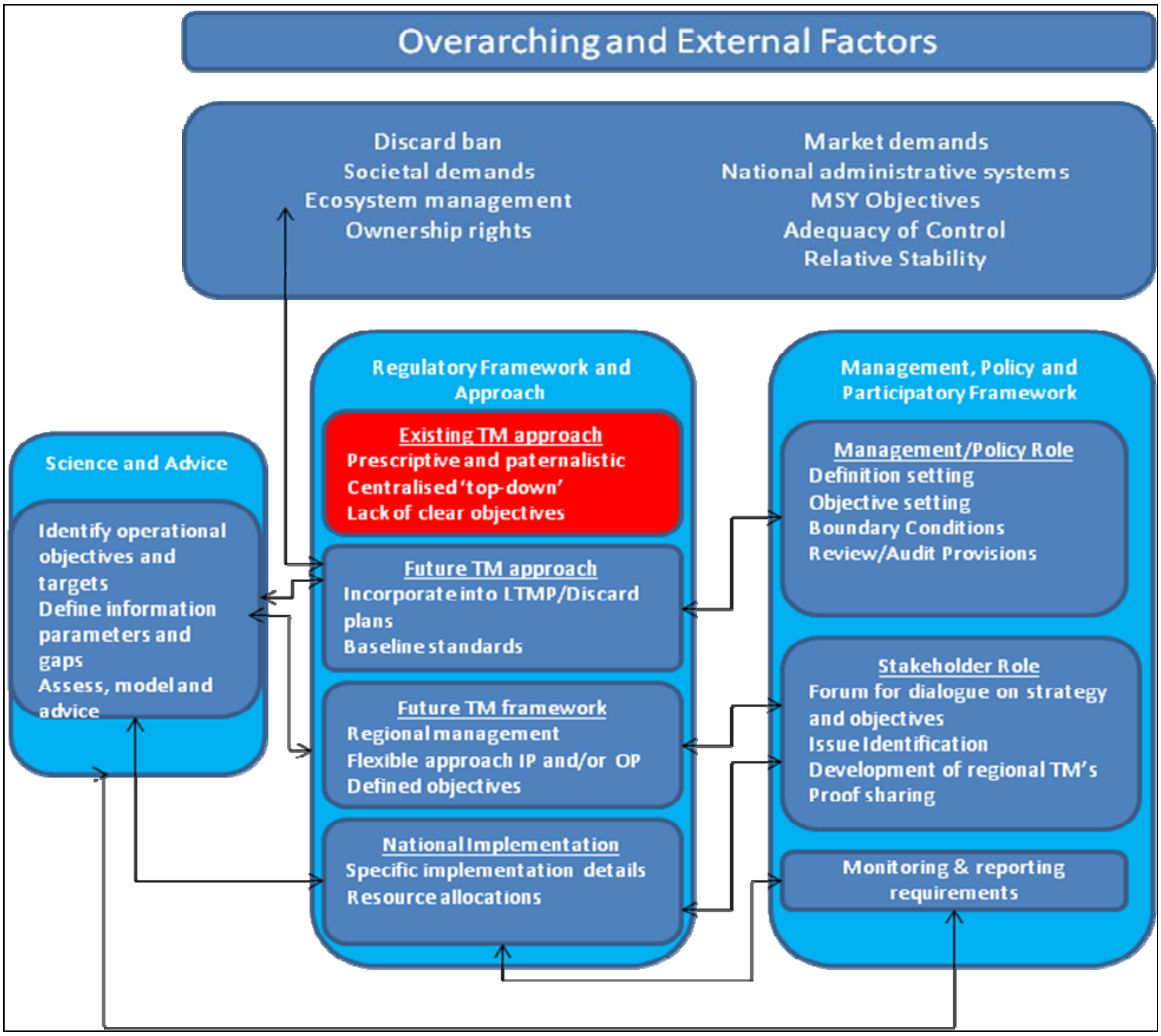

Figure 2.1 Technical measures in the context of the proposed reform of the CFP.

In the past multiannual plans have tended to cover single stocks and focus on defining targets such as fishing mortality rates and/or spawning stock biomass, as well as clear time frames to reach these quantifiable targets. However, under the reform it is envisaged that the scope of plans such be extended to cover multiple stocks where relevant and also to extend to include conservation measures and in particular technical measures. In this regard for the first time technical measures have the potential for direct linkage with the setting of fishing opportunities.

Additionally, issues such as changing consumer i.e. market demands, ownership rights, ecosystem objectives and the degree or efficacy of control and monitoring systems are all likely to influence the requirements of technical measures and how they are incorporated into the regulatory framework (Figure 2.1). The stated desire to adopt a more regionalised approach to the CFP, where broad overarching objectives are set at a European level and regionalised bodies are tasked with identifying and applying the specific instruments to achieve these will also require shifts in terms of how technical measures are evaluated in terms of achieving specific goals e.g. stock specific and multi-species F_{msy} targets for example.

In the context of the reform, EWG 12-14 also highlighted that a top-down approach may not be the most effective means of introducing technical measures, especially with regard to technical “details”. It considered a results based approach with appropriate impact metrics (impact referring to e.g. fishing mortality on fished stocks and damage to other ecosystems elements such as seafloor, seabirds) was a more appropriate way to address the current deficiencies of technical measures regulations. EWG 12-14 concluded that under a result based management system, where focus is on the achievement of clearly stated results and not on how the fishery is conducted, there will be a limited need to implement technical measures via specific regulations. However, there are difficulties with such an approach in terms of monitoring and control that may move away from prescriptive regulations but put in place an onerous and expensive control and monitoring system in its place.

To continue the work of EWG 12-14 it was decided at the STECF plenary meeting of November 2012 to form a second EWG, EWG-13-01, to look at a number of important issues that were not dealt with by EWG 12-14.. EWG-13-01 was thus tasked with reviewing the possibilities of a result based approach from an operational perspective as well as considering the primary objectives of technical measures in such a context.

2.1 Terms of Reference for EWG-13-01

The ToRs are as follows:

a) Identify tactical objectives that potentially could be achieved using technical measures in the context of results-based management.

b) Identify appropriate metrics to quantify the progress towards the tactical objectives identified in a).

c) Discuss and identify how impact metrics can be monitored and controlled and how the effectiveness of an impact based approach can be evaluated. This should consider required levels of compliance and difficulties associated in achieving these levels.

d) Explore the need for minimum standards (baseline regulations), focusing on specifications of technical measures, considering there will be a requirement for a transitional phase from the current input based approach towards a full impact based system as well policy objectives not suited to a strict output based approach e.g. MFSD, NATURA 2000.

The terms of reference given to EWG-13-01 are intertwined within the overall management approach and therefore it is not possible, nor advisable, to consider them in isolation. Therefore, the structure of the report does not necessarily follow the terms of reference in sequence.

2.2 Tactical Objectives of Technical Measures

Technical measures are part of a suite of input and output instruments which combine to influence both the exploitation rate and exploitation pattern with a primary goal of attaining sustainable exploitation of commercially exploited stocks and the provision of safeguards for wider ecosystem considerations.

As such they offer an objective means of affecting several aspects of the interaction between fishing activity on exploited marine organisms and the broader marine environment. This includes:

(1) ;Affecting the distribution of fishing pressure;

(2) Affecting the impact of fishing on both the physical and ecological environment; and

(3) Providing an objective mechanism of defining fleet management units based on their gear type and selectivity patterns.

We deal with these three objectives in the following sections.

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2.1.1. Technical measures as a means of regulating fishing pressure

In terms of fishing pressure, technical measures can affect both exploitation pattern i.e. the distribution of fishing pressure across the demographic (age/length) spectrum of a given stock and the overall exploitation rate through the deployment of species selective gears which avoid the capture of specific species in a given gear. Scott and Sampson (2011) note that the exploitation pattern has a significant influence on the point estimates of F_{msy} for a given exploitation rate and in general a higher age-at-capture (age at 50% selection) results in a higher F_{msy} yield (MSY). Exploitation pattern is a composite result of a range of factors including the selectivity characteristics of the gears, the harvest ratios by different gears, as well as seasonal and spatial distribution of fishing effort relative to the seasonal and spatial distribution of the resource. Technical measures through adjustments in gear selectivity, and measures that set spatial and temporal controls can contribute significantly to changes in exploitation pattern and therefore changes in the potential yield that can be removed from a stock due to changes in F_{msy} exploitation rates.

The 'new' CFP aims towards a regionalised approach with a greater participatory structure where stakeholders have a greater influence in terms of how the overarching CFP objectives (F_{msy}) are achieved. Recognising that technical measures can have a significant bearing on the F_{msy} yield and in the context of a regionalised approach, it is likely that the fishing industry in particular will seek the exploration of how different measures can contribute to achieving F_{msy} and other targets (e.g. under the MSFD). In addition, the recently proposed introduction of a discard ban under the reform of the CFP requires a shift of exploitation pattern towards the most valuable target size classes/species if businesses are to optimise their economic return associated with their fishing opportunities. In practice, as larger fish tend to achieve a higher price this will tend to focus selectivity in such a way as to avoid the capture of younger age classes. If there is sufficient faith in control and monitoring of catches e.g. through CCTV for example then it may not be necessary to specify the technical characteristics of the gears deployed apart from requirements for technical measures to provide protection for non-commercial species and broader ecosystem (e.g. habitat) objectives. This shift is expected to provide benefits, both in terms of mitigating growth overfishing and recruitment overfishing. Multiple studies (Beverton & Holt 1957, Froese et al. 2008) have shown that increasing size at first capture towards the size where the cohort biomass maximises (L_{opt}) allows the extraction of higher MSYs at lower levels of stock depletion. Recently, Froese et al. (2008) and Colloca et al. (2013) showed that shift in size at first capture closer to L_{opt} can result in higher benefits compared to just reducing fishing mortality. In addition, it has been shown that allowing fish to spawn at least once before they are caught also promotes fisheries sustainability (Myers & Mertz 1998; Vasilakopoulos et al. 2011). However, the above assumes that the optimal exploitation pattern from an economic perspective is consistent with that of the optimal biological or ecological exploitation pattern. This may not be the case where fisheries target juveniles (e.g. Mediterranean fisheries). There is also some evidence that changes in exploitation pattern, resulting in changes in demography, may also induce plastic (e.g. density-dependent) and evolutionary changes in growth and maturation (Heino and Godø 2002), and thus affect sustainability. Additionally the concept of balanced harvesting where the exploitation pattern is more consistent with productivity and tends to diminish with age, infers that there may be some degree of conflict between economic and biological/ecological optimums (Law *et al*, 2012). Many of these issues are still open to question both from an ecological and practical perspective. However, if there is evidence that the optimised economic selection pattern is at odds with biological/ecological consideration, then measures to influence exploitation pattern through the use of technical measures may still be required.

In practice, fisheries are mainly regulated by setting exploitation rate (fishing mortality or harvest rate) rather than exploitation pattern (selectivity) targets, which can currently be considered as flanking measures. Worm et al. (2009) focused on exploitation rate as the proximal driver of stock status. However, exploitation pattern influences MSY and F_{msy} (Scott and Sampson 2011) and stock status. The effect of exploitation pattern is not considered in the current assessment and advice process, where usually a status quo exploitation pattern is (implicitly) assumed. Currently, minimum landing sizes are mostly well below size at maturity and L_{opt} (Froese et al. 2008; Khalilian et al. 2010). In other words, current management underutilises the potential of exploitation pattern as a driver, in addition to exploitation rate (F), for the achievement of MSY targets.

Scott and Sampson (2011) show that increasing the mean age-at-capture, assuming an asymptotic exploitation pattern curve, results in a higher MSY obtained with different (mostly higher) F_{msy} values; see figure 2.1.1.1. This finding has been shown to hold for a wide variety of inputted biological parameters and a variety of exploitation pattern curve shapes (Vasilakopoulos, in prep.). Another metric of exploitation pattern that has been shown to reflect the effects at the stock level is the ratio of F on immature over F on mature individuals weighted by abundance (F_{imm}/F_{mat}; Vasilakopoulos et al. 2011).

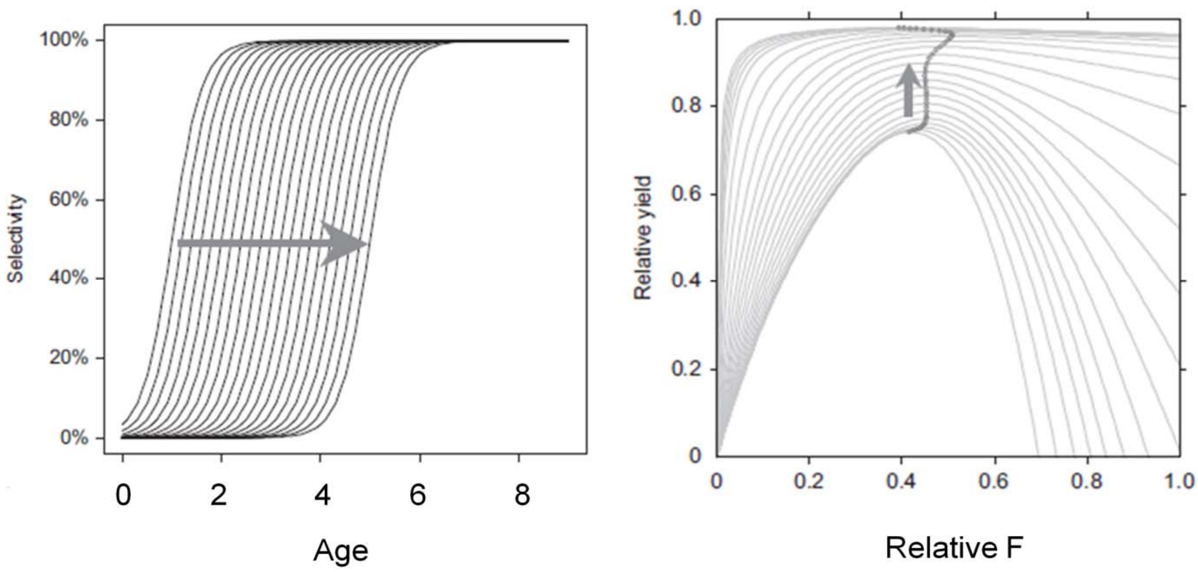

Figure 2.1.1.1 population-selection curves (left hand panel) assumed for the equilibrium yield versus F relationships shown in the right hand panel assuming an asymptotic selection pattern. The arrows indicate the ordering of the series. From Scott and Sampson 2011.

To explore the potential of exploitation pattern and exploitation rate combined as drivers for the achievement of higher MSY, the short- and long-term effects of increasing age at first capture on the dynamics of a simulated exploited ‘cod-like’ population were investigated by EWG 13-01. Two shifts in age at 50% selection (A_{50}) were investigated. The age at maturity of the fish was assumed to be 3 years. The baseline run with A_{50} = 3 years resulted in an F_{msy} = $0.16y^{-1}$ which produced an MSY=10,300 tonnes. The simulated population was projected forward for 20 years exploited at the F_{msy} level (0.16) with A_{50} = 3 years, and then the A_{50} shifted to an older one, 4 or 5 years respectively, and was then projected for another 20 years. Table 2.1.1.2 presents for each A_{50}: (i) the corresponding F_{imm}/F_{mat}; (ii) the yield in the first year (STF, Short Term Forecast) after the A_{50} change under the status quo F (0.16); (iii) the recalculated F_{msy} for the new exploitation pattern (Figure 2.1.1.2); (iv) the yield in the first year after the A_{50} change under the new F_{msy}; (v) the equilibrium yield (after 20 years) under the status quo F (0.16) with the new A_{50}; (vi) and the equilibrium yield (after 20 years) under the new F_{msy} (MSY). In all cases the F referred to is the F of the fully-selected age class.

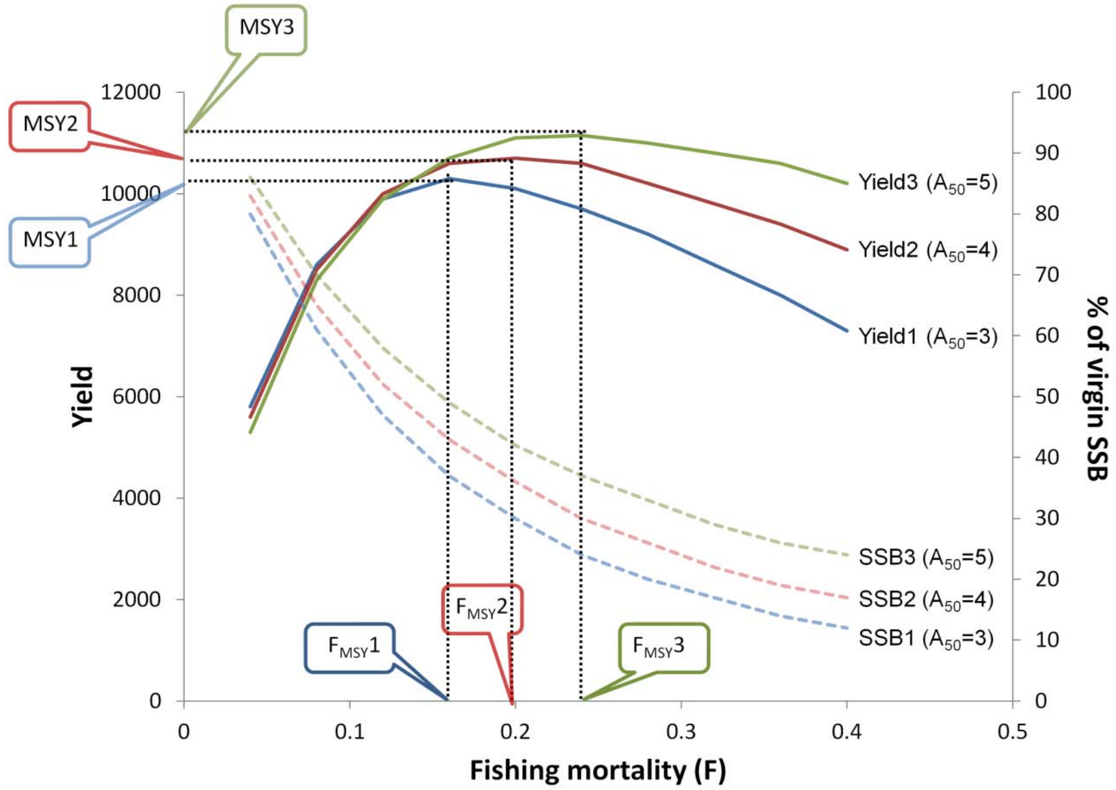

Figure 2.1.1.2 Equilibrium yield and SSB as a function of F, and MSY and Fmsy, under three scenarios of A50 (see text)

2.1.1.1. Age at 50% probability of capture (A_{50})	2.1.1.2. F_{imm}/F_{mat}	2.1.1.3. STF yield under *status quo* F_{msy} = 0.16	2.1.1.4. New F_{msy}	2.1.1.5. STF yield under new F_{msy}	2.1.1.6. Equilibrium yield under *status quo* F_{msy} = 0.16	Equilibrium MSY (under new F_{msy})
Current = 3y	1.1.1. 0.37	1.1.2. 10300	1.1.3. (0.16)	1.1.4. 10300	1.1.5. 10300	1.1.6. 10300
1.1.7. Change from 3y to 4y	1.1.8. 0.24	1.1.9. 9300	1.1.10. 0.20	1.1.11. 11000	1.1.12. 10600	1.1.13. 10700
1.1.14. Change from 3y to 5y	1.1.15. 0.15	1.1.16. 8100	1.1.17. 0.24	1.1.18. 11000	1.1.19. 10700	1.1.20. 11100

Table 2.1.1.1 Results of simulating shifts in A50.

As expected, an increase in A_{50} is reflected in the decrease of F_{imm}/F_{mat},, suggesting that F_{imm}/F_{mat} is a good proxy for capturing the changes of mean-age-at-capture taking place. Table 2.1.1.1 shows that the short term effect of increased A_{50} under *status quo* F, is a loss of yield but in the long term a gain in yield is seen. If the new (increased) F_{msy} is applied immediately, this results in a gain in yield in the short as well as the long-term. From an economic viewpoint it is, however, necessary to contrast the short term losses with the long term benefits in yield. The relative changes will determine whether fishermen will support such a change in exploitation patterns.

Note that the increased F is likely to be associated with increased effort but it cannot be inferred *a priori* whether this is the case (owing to the fact that the increased A_{50} may be achieved by a technical measure that increases efficiency on older ages). In our simulated stock, the mean lengths at the ages 3 years, 4 years, and 5 years are respectively 60 cm, 73 cm, and 83 cm. If the shifts in A_{50} were to be effected solely by changes in mesh size this would imply, that for every 3.3 cm increase in A_{50} a 10 mm increase in mesh size is needed (unpublished model), and therefore two simulated shifts in A_{50} amounts to increases in mesh size of respectively ~40 mm and ~69 mm. This is of course unrealistic but shifts in A_{50} can also be achieved by other means, e.g. by spatial-temporal shifts in effort allocation towards areas and seasons where smaller fish can be avoided. In this preliminary simulation the age at maturity is coincident with the initial A_{50}. The positive effects from increasing A_{50} would likely be higher if the baseline A_{50} would have been below the age at maturity, which is the case in most exploited stocks. This example is for illustration purposes only, and stock-by-stock analyses should be undertaken to indicate the effects of changes in exploitation pattern on F_{msy} and MSY and short-term effects on yield. Nonetheless it shows the potential for this type of approach in terms of for increased fishing opportunities in reward for positive changes in exploitation patterns.

The exploitation pattern implemented in these preliminary simulations is asymptotic, whereas the overall exploitation pattern for a stock depends not only on the gear configuration but also on the spatial and temporal distribution of the fishery and underlying population. These can potentially result in complex exploitation patterns. Consequences of the exact shape of the exploitation pattern will likely be stock- and area-dependent with single- and multispecies considerations. Evaluation of the exact shape of the exploitation pattern requires stock-specific investigation.

In order to describe exploitation pattern, different metrics will need to be implemented depending on the scale of interest. At the gear/vessel level, age/size at first capture (A_{50}/L_{50}) or a relative metric of age/size at first capture taking into consideration the age/size at maturity (A_{m50}/L_{m50}) could be used, e.g the difference between A_{50}/L_{50} and A_{m50}/L_{m50} (Vasilakopoulos et al. in prep.). At the fleet level, a similar metric could be used, taking into consideration the exploitation pattern resulting from the fishing activity from all gears/vessels of the fleet. At the stock level, given the great variety and complexity of exploitation pattern curves observed in empirical stocks (Sampson and Scott 2012) it could be harder to calculate an objective age/size at first capture. Therefore, at the stock level, the F_{imm}/F_{mat} metric could be used as a metric of exploitation pattern as it can be calculated over any kind of exploitation pattern curve.

Currently, short-term forecast and fisheries advice are based exclusively on Fbar (exploitation rate); adding an F-based metric of exploitation pattern (F_{imm}/F_{mat}) in this process could enhance the quality and explanatory power of the assessments. Inclusion of such a metric in the stock assessments and fisheries advice would also illustrate a greater range of possible exploitation regimes, providing more choices to the industry. In any case, as with exploitation rate metrics such as partial Fs (at the fleet level) and Fbar (at the stock level) that are stock-specific, exploitation pattern metrics should also be investigated on a stock-by-stock basis.

EWG-13-01 considers that further exploration is required on how technical measures (gear/spatial/temporal) as drivers for changes in exploitation pattern can be formally integrated into multiannual management plans, along with existing measures e.g. TACs which aim to control exploitation rate is worthwhile. This would involve describing the potential changes in yield associated with different exploitation patterns (EP) and Fmsy point estimates and could potentially be achieved by a direct link between exploitation pattern and yield through a harvest control rule type approach, where the Fmsy is routinely recalculated to consider changes in exploitation pattern.

In the context of technical measures and their influence on the exploitation pattern and impact on F_{msy} point estimates, including exploitation pattern as a 'yield-multiplier' would have the benefit of directly linking fishing opportunities with the selectivity of the fleets exploiting that stock thereby offering quantifiable advantages of improving exploitation pattern . Thus far such linkages have been absent from catch forecasts and technical measures have tended to be treated externally to the setting of fishing opportunities. Internalising changes in EP in terms of changes in potential yield provides a real commodity to incentivise change such as has been achieved through the conservation credit approach developed in the UK (see section 2.1.8 of this report). However, such an approach is not without limits and disadvantages. Further exploration on a stock by stock basis is required to assess what the potential increases in yield could be in practice and what changes in exploitation pattern are required. The initial simulation presented here would indicate that if mesh size alone is used to adjust the exploitation pattern, then the increases are substantive and in a mixed-fisheries perspective, may not offer an acceptable solution. Additionally, the exploitation pattern at a stock level is comprised of multiple and varying contributions across fleets/metiers and different MS engaged in the fishery, some of which will have comparatively low or high EP's. Metiers will have different abilities/desires to change their exploitation pattern, and given that the principle of relative stability embedded in the allocation of fishing opportunities in EU fisheries is likely to remain fixed, rewarding/penalising those MS which contribute the most/least to a positive EP will probably not be possible without impacting on relative stability. Therefore incentivising fleets/metiers may only be possible at a MS level. Notwithstanding this, one would hope that in the context of regionalisation, bodies responsible for fisheries management at this level would work collectively to enhance the exploitation pattern as all MS could gain through a proportional increase in fishing opportunities if they operated in an optimised way

While the concept of internalising technical measures with other management instruments by linking directly with available fishing opportunities has obvious benefits, the concept has limited use in areas where there are no catch allocations, where different components of the stock demographics (e.g. juveniles and adults) are targeted or where the jurisdiction over a stock is only partial e.g. high seas fisheries. In the Mediterranean, fisheries are regulated by effort control combined with technical measures (selectivity of gears, protected areas, seasonal fishing bans, minimum legal size in landings for some stocks, etc). No quotas are allocated by country or by fishing techniques except for some particular stocks (e.g. highly migratory species regulated by ICCAT) as well as national quotas for bivalve molluscs. Measures taken are designed to reduce fishing effort and to avoid the capture of juveniles. However, the high frequency of mixed fisheries, the small numbers of adults of many target species and the high market demand for juveniles of commercial species that may reach larger sizes historically condition the selectivity capability of the gears used.

The diversity of gears in use, the high development of small-scale fisheries, the presence of many ports and landing sites spread along the coasts and the existence of mixed fisheries with not well defined target species, make it difficult to assess both the current stock status and the likely consequences on the stock size and yields of changes in fishing mortality. Also difficulties exist in mapping the available amount of catches of stocks shared with non-EU countries fleets. However, new rules imposed in the General Fisheries Council for the Mediterranean (GFCM) that encourage data sharing and other multilateral cooperation to promote the development, conservation, rational management and better utilisation of living marine resources in the Mediterranean and the Black Sea have improved the situation. In recent years, catch data for some stocks shared by EU and non-EU countries are available and some assessments are now performed. In addition the STECF EWG on the Mediterranean, stock assessments are regularly performed per Area divisions (Geographic Sub-areas), but are limited to only some important stocks. F-based Reference points (F0.1, F_{msy}) are regularly defined. This EWG also carries out analysis of management scenarios and harvest forecasting assuming changes in exploitation rate. Estimates of variations in yield derived from management options based on changes in exploitation patterns have been derived for some stocks. These analyses, however, are only feasible for stocks for which F-at-age by métier information is available. The analyses can be considered extremely useful despite the fact that the results cannot be translated into the allocation of fishing opportunities (i.e. quotas). The metrics for measuring performance of the implemented measures can be the same or similar to those potentially useful for managed stocks: changes in biomass or in total catch, F at age, demographic structure (whenever some Reference structure can be defined as desirable), fraction of adults in the stock or in the catch but as occurs in the case of stocks that are managed through quotas, it is in many cases very difficult to disentangle the relative influence on the results of management measures based on EP to those based on ER.

It is also important to note that many stocks in the Mediterranean are considered in a growth overfishing status, with high exploitation rates and an extremely small size of first capture. Aiming at an improvement of the exploitation pattern, in recent years the EU and GFCM imposed a very moderate increase cod-end mesh size for all demersal trawls, with the expectation of improvements in selectivity for many commercial species. Simulations of changes in EP can be more complex, because sometimes they deal with not only the selection ability of the gear, but also on alternative ways to determine the exploitation pattern (i.e. through a major pressure in certain areas where individuals of certain sizes are more concentrated, through seasonal changes in frequency of use of certain gears or areas targeting certain stock). The Mediterranean fisheries are very dynamic and adaptive. Difficulties for the performance of reliable simulations can be linked to the unpredictable reactions of fishermen from the enforcement of new technical measures. Such reactions can be expressed as changes in the frequency of use of gears or in the spatial/temporal distribution of fishing effort.

2.1.2. Technical measures in the context of ecosystem objectives

EWG 12-14 concluded that technical measures have an important role in terms of wider ecosystem considerations. These include limiting fishing impacts on low productivity species caught in mixed species fisheries; incidental catches of protected species (e.g. marine mammals and seabirds) and protection of sensitive habitats. Increasingly, sensitive areas are being closed to certain gear types. Technical adaptations to gears can help minimise habitat impacts. It is likely however that area/gear restrictions and closures will remain the central approach to protecting habitats and vulnerable epifauna.

In relation to the application of technical measures in the future CFP, EWG 13-01 considered the requirements of the MSFD and NATURA 2000 and concluded that the following are relevant

- recovering and maintaining the conservation status of ‘features of conservation interest’ (foci) and species identified under the Birds and Habitats regulations;
- maintaining biological diversity;
- maintaining populations of all commercially exploited fish and shellfish within safe biological limits;
- ensuring that all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity
- recovering and maintaining sea-floor integrity at levels that ensure that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

Concerning the achievement of Good Environmental Status (GES) under the MSFD the majority of Member States seem to acknowledge that the reformed CFP is the mechanism for providing a robust framework for the sustainable management of marine biological resources and ensuring a level playing field in Community waters. The kinds of measures which are most likely to achieve this include technical measures that improve gear selectivity, eliminate discards, spatial/temporal restrictions and output measures e.g. catch or landings limits. All of these are already in place across our fisheries in some shape or format. They have been evaluated by statutory conservation advisors to MS governments .

Specific requirements of the descriptors contained in the MSFD are expressed in terms of indicators of GES. It appears that the indicators for Descriptor 1, maintaining biological biodiversity, will be delivered by following the OSPAR guidance on the required proportions and levels of given habitats and species. MS's are starting to incorporate these into national legislation by the designation of marine protected areas that are spatially defined and where anthropogenic impacts are managed in appropriate ways.

Descriptor 3 requires that populations of all commercially exploited fish and shellfish are within safe biological limits. The indicators associated with this relate to fishing mortality levels (F), catch:biomass indicators, SSB levels/biomass indices, population age and size distribution and age at first maturity.

Descriptor 4 requires that all elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity. Only some of these elements/species fall within the scope of fisheries management and hence the ToRs of this EWG:

- production per unit biomass of key commercial species
- short-lived pelagic species
- groups/species targeted by human activities and
- top predators

where they are distributed within Community waters, can all be managed by the metrics in section 2.1.5 of this report.

Additionally to determine whether this is an appropriate way to flag potential bycatch issues of sensitive species and thereby guide decisions as to where monitoring is required, ICES has looked at several approaches that may be relevant for future management of such species. Integral to this is looking at the amount of bycatch against some predefined acceptable There are a number of ways to generate the acceptable limits and these include the Potential Biological Removal Rate (PBR) or Catch Limit Algorithm (CLA) for example.

Descriptor 6 relates to sea-floor integrity and safeguarding the structure and functions of benthic ecosystems. It is widely recognised the seabed is vulnerable to disturbance and modification by fishing activities and that the degree of vulnerability is related both to the sensitivity of the seabed and the types of impacts resulted from different types of fishing gear. Many years of research have resulted in matrices that describe the possible combinations and the management options for mitigating them (refs). Inevitably these are predominantly spatial and temporal management, based on the sorts of measures described in relation to Descriptor 1 above.

In conclusion metrics associated with results-based management are only relevant to Descriptors 3 and 4: the indicators relating to Descriptors 1 and 6 will mainly be delivered by the presence or absence of particular fishing operations in given areas. The other potent tool for effort management is the new generation of high resolution VMS systems that can help to maintain the production of seafood whilst respecting the conservation imperatives that drive marine environmental management.

2.1.3. Technical measures for defining management units

Managing fleet units based on homogenous characteristics is an important component of mixed-fisheries and fleet based management. Hilborn (2007) noted that understanding fishermen's behaviour through the aggregated behaviour of fishing fleets is a key ingredient to successful fisheries management. The movement towards such approaches, where advice is focussed at the level of the fleet or fishery rather than the stock, requires the establishment of management units (fleets) which can be defined based on homogeneity of vessel and gear characteristics. To this end, technical specifications of the gears and mesh sizes used by different fleets are commonly used as part of fleet definitions. Technical regulations (mesh size and gear type) by default define the fleet 'bin' that an individual vessel belongs to at a given time, so the gear characteristics in themselves are not management instruments *per se*, only descriptors. For instance, under the current regulatory system, the permissible mesh size is defined by the retained catch composition and area of operation while under the LTMP for cod (Regulation (EC) 1342/2008) demonstrates how technical specifications of the gears (gear type and mesh size) have been applied to define fleet management units e.g. TR1, BT2 etc, etc. This raises two issues for consideration.

Firstly, the level of aggregation is a compromise between maintaining some degree of homogeneity with respects to the stocks/size groups captured and the broader effects on the environment. In an evaluation of the TR1 grouping (>100mm), STECF (PLEN 11-03) noted that the degree of homogeneity varied considerably across management areas and the decision to broaden the existing gear groupings was really a question of administrative burden. However, STECF (PLEN 11-03) also noted that if there are preferential fishing opportunities in one gear grouping over another, then this could incentivise movements across gear grouping that could have unintended consequences. Nonetheless, given the move towards mixed-fisheries management approaches, it is likely that gear categorisation and potentially, the selective characteristics of the gears, will remain an important descriptor for defining management units.

For the purposes of stratifying sampling programmes, the Data Collection Framework Regulation (EC) 199/2008) uses level 6 criteria which encompasses gear type (Level 4), mesh size (including any selectivity device in use; Level 6) as well as nationality, vessel size and spatial-temporal area fished. Given the broad spectrum of metiers and fleets operating across the European EEZ, it is unlikely that management units which have a reasonable degree of homogeneity in catch profiles and broader ecosystem impacts could be found that are able to reconcile catch profile/impacts with any degree of cost efficient management burden. For example, Davie and Lordan (2011) identified 33 different metiers associated with the Irish otter trawl fleet, such a level of resolution is not practical from either a management or sampling perspective and need to be collapsed at some level if they are to offer tractable management units. The degree of aggregation is something that needs to be decided at a broad management and stakeholder level where there is a trade-off between the desire to have management units that are homogenous in terms of catch and impact against the administrative burden of management. It is likely that this will be case specific. For example, where there are few metiers and target species, a high level of resolution may be possible at an individual MS level and vice versa.

The second, more fundamental issue relates to the continued use of mesh size to define a specific fleet. EWG 12-14 identified a wide range of issues associated with a prescriptive approach to technical regulations and in the following sections of this report, we consider how a more results driven approach may be more effective and appropriate. If fully effective, one of the consequences of an RBM is that there would be no need for technical regulations and this would mean that one of the key fleet (input) descriptors would be removed. Therefore, alternative input based metrics would be required for defining fleet units or, mesh size regulations could simply become contributing features for defining fleet units with no specific objective related to the catch.

In developing a new technical measures regulation this issue needs to be considered otherwise we run the risk of having indefinable fleet units making management difficult.

2.3 Technical Measures and a Results based approach

2.1.4. Strategic elements and incentive structures in RBM systems

In the EWG 12-20 report STECF highlighted the following strategic elements of adopting a results-based approach in the future development of technical measures:

(1) Output control versus input control, creates an incentive to develop technology supporting the achievement of agreed aims resulting in acceptable levels of negative impacts.

(2) Burden of proof is shifted from managers to the industry.

(3) Enforcement is based more on the concept of commitment than compliance, and the monitoring of enforcement includes elements from peer pressure.

(4) The management approach and the incentive structure can have a significant impact on the effectiveness of technical measures.

(5) Positive incentives with rewards for doing certain things may work better than penalties.

EWG 12-20 reported on the general concept of incentives and the special situation in respect of technical measures. It is clear that regulations which create incentives to reach management targets can be more robust and hopefully successful by ensuring that those who have the greatest impact on fisheries have an increased interest in the success of the regulations (e.g. higher yields in the future if they now bear the costs of overexploitation). However, in complex management environments like fisheries it could be a challenge to achieve this.

The current technical measures lack clear policy objectives, resulting in very detailed technical regulations with few incentives to comply, minor success in achieving objectives and limited flexibility in the management system. Fishermen have also a very short term security on revenues and suffer from the introduction of technical measures due to an increase in costs of operation. Additionally, in some cases regulations are contradictory and, therefore, it is unclear which direction fishermen have to follow. The main problem for fishermen is the loss of revenues (at least in the short term) when new measures are introduced. Therefore, this is a clear negative incentive as with unclear objectives and targets, the introduction of detailed technical regulations increase costs without any security of at least long term gains.

Results-based management (RBM) can be defined in fisheries as management by objectives and targets where fishermen enjoy a maximum freedom to choose and developed technology and methods to optimise results that meet these objectives and targets. RBM ensures incentives for the fishermen to steadily improve results and it produces knowledge relevant for gradual development of targets. In a results-based management scenario, the objectives and standards need to be agreed at a political level. Control and enforcement holds the results-based activities up for scrutiny. This is a different type of approach compared to the current control and enforcement activities within the CFP that is largely driven by top-down management regulations. In a pure results-based scenario, the fishing industry would be responsible for monitoring and control their activities as part of their license to operate. Of course this would need to be matched up with appropriate freedom to act as responsible operators (and so without too many restrictions on how they achieve their targets). However, this assumes that all the actors are behaving in a responsible way to achieve the policy objectives. Without adequate independent monitoring at the level of an individual business, it could result in 'free-rider' problems. In the absence of appropriate monitoring, some business may choose to adopt measures to minimise unwanted catches, which could result in short term losses. Other 'free-riders' (those who don't change behaviour) may then benefit without paying for the cost. If there are sufficient ‘free-riders’, then no benefit is accrued and the individuals who have acted in a responsible manner are effectively penalised twice.

The introduction of a RBM system would change the actual, negative incentive structure to a more positive, proactive structure which gives the fishermen a reward for reaching management targets. This incentive structure includes clearer policy objectives (e.g. MSY and the elimination of discards) with targets or goals which clearly follow from the objectives (e.g. F_{msy}, minimum conservation reference size). Having such clearly defined targets would also help (would be necessary) in hind cast evaluations undertaken to assess the effectiveness of the actions undertaken by fishermen in achieving the policy objectives. In many cases multiple measures may be chosen by the industry to achieve a target and fishermen may be free to choose between different ones or develop their own. This freedom to choose may give them incentives for technical innovations to lower the costs of implementation and from the perspective of an individual business, freedom can be considered a significant asset. There are already positive examples with the introduction in the cod plan resulting in the introduction of the Scottish conservation credit scheme. Under this scheme there have been numerous examples of such technical innovations as fishermen have strived to develop innovative gears to minimise cod catches.

Linking incentives to outcomes is difficult enough when managing single species, with the relatively simple problems of limited exploitation and localised effects. It is even more complicated for entire ecosystems, where exploitation is interconnected with system-wide ecological and economic effects (Hanna, 1998). However, with a flexible, adaptive management approach it should be possible to define targets in an ecosystem context (see approach of the MSFD).

Figure 2.3 shows the structure of a RBM system and includes responsibilities of the fishing sector and the Scientific Community. In addition the results of the assessment of success must lead to action by the EU or member states if the targets are not achieved.

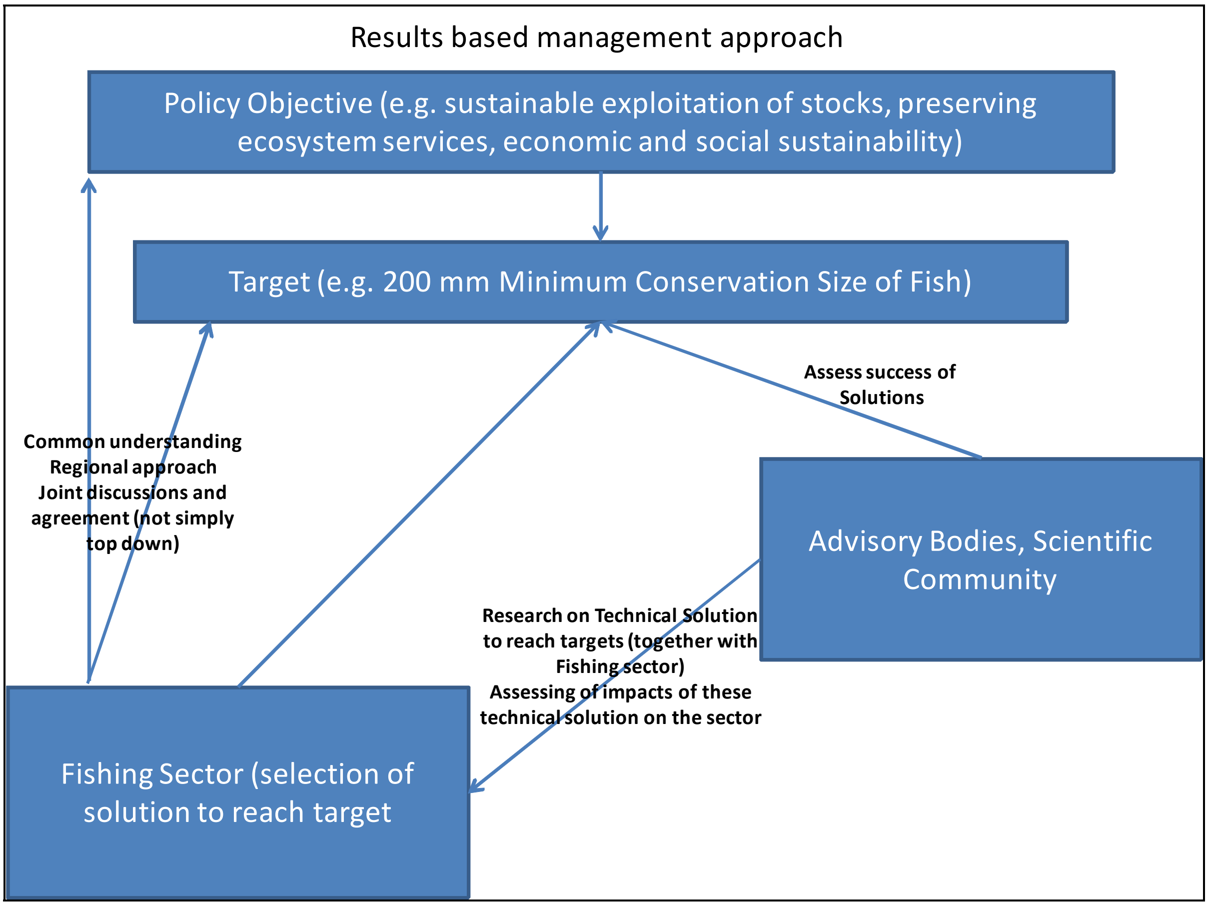

Figure 2.3 The structure of a RBM system and the responsibilities of the fishing sector and the Scientific Community

In practice there are a number of considerations, advantages and disadvantages to the implementation of a Results Based Approach as a means of replacing the current prescriptive based approach. These can be loosely broken down into:

- Choice of appropriate metrics and can these be used to gauge progress (or the 'result') and are how they are linked to the policy goal;
- Administrative, monitoring and control considerations - processes required to change from a prescriptive (technical definitions) approach and where the responsibility of proof lies in an RBM approach.
- Industrial considerations and responsibility – does an RBM offer a 'better' approach; do the industry understand/agree with the choice of metrics; do they require additional technical support to achieve desired outcomes; is there an improvement or violation of the concept of a 'level playing field'?

2.1.5. Selection of appropriate metrics in an RBM system

EWG-12-14 identified some examples of bad legislative practice where the technical specifications in the regulation which are unduly complex (e.g. including legal text on how to repair meshes in a Bacoma panel)., while the current objective of technical measures of minimising the capture of juveniles and other unwanted organisms does not offer specific, quantifiable goals. The lack of specific targets in the current approach to technical measures regulations therefore does not support the implementation of RBM, so in the first instance, to implement an RBM system would require the identification of appropriate metrics. Under a RBM approach it is necessary that the metrics can be clearly linked to the specific policy objectives and that they are agreeable and achievable. In the context of technical measures, RBM has benefits in that metrics are more directly linked to the objective of manipulating catch patterns to meet management objectives i.e. minimisation of unwanted catch. In contrast, compliance with regulations detailing the configuration of fishing gear being used does not directly link to delivering of target catch profiles. Therefore, successful implementation, provided the correct metrics are chosen, is more likely to deliver stock benefits and management objectives. However, there are a number of considerations when selecting appropriate metrics. Fitzpatrick *et al*, (2011) considered the RBM approach and the challenges surrounding the issue of burden of proof. In terms of monitoring the efficacy of the RBM approach, the authors note that responses can be measured *in situ* (on the vessel) or *ex situ* (at the stock or ecosystem level). *Ex situ* metrics are useful in terms of whether the overall objectives are being met for example low fishing mortality rates on a particular age group, or other broad measures of 'sustainability'. Using an RBM approach as an alternative to prescriptive technical regulations will require appropriate *in situ* measures in order to demonstrate that individual business are operating within particular and pre-agreed (e.g. catch profiles) boundaries otherwise there is a significant 'free-rider' risk (see above). *In situ* metrics are preferable because they give direct measurements, although they can be invasive and costly. *Ex situ* results are only observable on scales that make it difficult to attribute them to specific management measures, or they may be influenced by external factors.

The metrics selected for a catch-RBM approach need to reflect the management objectives, for example a desired catch profile would be represented by some output target. This could include defining a minimum size of fish that could be selected and would represent the catch profile. Conservation Reference Sizes, as mentioned in the CFP reforms, offer such a potential metric to develop a catch-RBM approach. These are proposed as a replacement for the current legal Minimum Landing Sizes under the proposed landing obligation. Exactly what the CRSs are, and how they will be set has not yet been agreed in the CFP reform process but it is clear that the format of CRSs should be based on what it is they are meant to achieve. If they are to be used to deliver a catch-RBM approach then they need to be set with this in mind. Using such a metric, the catch would be split into fish above and below this size and the proportion or amount of the catch below this size would be the output result. A limit on the contribution of fish under this size would make up the control element of this results based approach. The format of the output could be in numbers or weights and set as a proportion or percentage of the catch. The size selected could be based on examination of F-at-age information for assessed stocks, to determine which size would be most likely to deliver the desired catch profile.

Implementation of this system, however, might lead to an incentive towards non compliance with the objectives of the obligation to land all catches. A limit on catch percentage of small fish may result in unintended negative consequences that counteract the intentions behind the obligations to land all catches. In accordance with the landing obligation a fisherman must land everything, but specimens smaller than CRS cannot be sold for human consumption. There is thus an economic incentive to avoid catches below CRS. A limit on catches below CRS would not just dis-incentivise but in addition penalise catches of small fish and thus create strong incentives to avoid detection. In a control regime without full documentation there is a high risk that this will result in discarding of catch below CRS, which will not be landed and counted against the quota in accordance with the landing obligation. With the introduction of (hard) sanctions for failure to meet the output targets the incentive framework of Catch-RBM increases the risk of non-compliance with a ban on discards. This is the main weakness of a results based approach based on catch patterns in the context of European fisheries.

When considering limits on the catches of specific species, it would also be possible to have multi-species catch profiles based on the outputs of mixed fisheries modelling, however given the underlying assumptions of fixed catchability and activity, this is unlikely to offer the level of precision required to operate this at an individual vessel level. Proportions-at-age and at-length as output results could also be considered, although these would provide an output result matching more closely the target catch profile, making it impractical to impose a higher resolution selectivity target at a vessel level.

As the stocks of the included species change relative to one another, however, the desired catch profile and, therefore the selected size, would need to be adjusted and it is questionable given the other sources in variability, how realistic setting targets based on (ever changing) percentages relative to the overall catch could be done in practice. STECF (PLEN 02-11) note that the use of percentage targets as part of the long term management plan for cod can induce unintended negative incentives and that setting percentage limits based on length or species catch compositions is not appropriate. For example, setting a species specific catch limit based on the percentage of the overall catch could incentivise fishermen to decrease selectivity on other species which would allow for higher catches of the restricted species while maintaining their overall percentage contribution to the catch.

Related to this issue is the need to identify a number of catch profiles that would describe different components of the fleet, which, in combination, will deliver the stock level target catch profile. So decisions would be required on how the various fleet components would contribute to the overall catch profile. Moreover, for those fisheries that are not fully documented, assumptions on the representativeness of catch profiles would be required in order to aggregate vessels into different fleet segments.

Recruitment pulses will also cause problems in fisheries that are for the most part complying with the system. Influxes of sporadic recruitment pulses decrease the probability of fishermen achieving their targets despite the fact that they may have been compliant earlier. In certain fisheries fishermen can adjust to this by incorporating various technical measures and using their knowledge to comply with the percentages. This would imply a degree of gear complexity in the measures that would be difficult to devise and implement. SGMOS(08-01) showed how population structure (length) can affect the perception of the effectiveness of an improvement in selectivity if the percentage of fish below a given length is used as a metric. It is noted that even with a substantive improvement in selectivity, which results in comparatively high reductions in the retention of small fish, when comparing ‘old’ and ‘new’ gears, it is noted that if fished on a population which comprises of few 'large' fish, the percentage of undersize fish retained relative to the overall catch is only marginally lower with the more selective 'new' gear.

Apart from recruitment variability, catch profiles vary due to a number of controllable and uncontrollable reasons for which there may or may not be strategic solutions. It could be possible to include flexibility into the output result, i.e. the percentage contribution of fish below the defined size, based on factors external to the control of the industry (e.g. recruitment pulses). The benefit of this would be in enabling adjustment to large pulses in recruitment. A static output result would not account for large numbers of fish recruiting to, or moving into, a fishery; effectively, a higher proportion of fish would have to be avoided to stay within the amount of small fish allowed. However, by adjusting upwards the percentage contribution of small fish, the same selectivity profile could be delivered and the fishers would not be disadvantaged. This adjustment could be based on the changes in population structure identified in the surveys, and an annual population structure would be defined to calculate the output result that will deliver the target catch profile implying that there would be a need for periodic re-evaluation of the targets.

In practice, given the continued changes in population levels and structure within and between species, the use of catch based metrics as a means of target setting (for the industry) and to attain specific stock (policy) objectives, is likely to require continued re-evaluation of targets to take into consideration the changes in populations over time. While in principle, a switch towards a results based system where a catch demographic is used could greatly simply technical regulations, the choice of catch metric needs careful consideration with regard to changes in populations.

As an alternative to a catch based metric, it may be possible to identify a minimum selectivity requirement (selectivity profile) or baseline gear and leave the technical design features to the industry to develop, the concept being that the industry could develop gears that will have the same selectivity profile. This will require cooperation between industry and gear scientists to evaluate gear equivalence. This type of approach has been followed in developing a new package of technical measures for fisheries in the Skagerrak whereby a baseline codend minimum mesh size at 120mm in demersal trawls and seines. The advantage of this approach over a catch based metric would be that the target selectivity would not require ongoing adjustment to account for changes in the underlying population(s). However, it is likely that this type of approach would lead towards a list of approved gears simply due to control and enforcement issues, but as show in the example given in section 2.1.9, this does not necessarily require an excessive administrative and legal burden.

While this approach suited the fisheries in the Skagerrak which are relatively simple, the EWG concluded that as a general approach across sea basins it would be difficult to implement given the diversity and complexity of fisheries. It would be problematic to define single reference gears and undoubtedly in the course of negotiating a new regulation MS would seek multiple gear options with the result that the final regulation would end up similar to the current situation with multiple mesh size regulations. However, it may be useful as a tool at a regional level as part of a multiannual or discard plan as insurance that conservation objectives are still being met. In the context of alternative gears, it would also be important to consider the potential differences in escape survival. If a particular gear or species results in elevated escape mortality in comparison to the minimum standard, then the overarching stock benefits may not be realised in practice. How this could be demonstrated is problematic given the resources required for survival studies.

2.1.6. Administrative, monitoring and control considerations

The RBM approach is considered to be less bureaucratic requiring fewer regulations relative to the current suite of technical measures which is characterised by a growing number of increasingly detailed regulations that are difficult to interpret for controllers and fishermen alike. Additionally, setting specific catch limits or thresholds offers the opportunity to incorporate a (coercive) incentive, whereby sanctions would be imposed if target levels of undersized catches were exceed. For example the requirement to change areas, limitation on fishing opportunities or fines linked to the catch composition (the objective) rather than the technical specification of the gear. The sanctions for non-compliance would therefore internalise the cost of having an undesirable catch profile (further relevant details on this issue were covered previously in STECF (2008)). Such an approach could utilise existing protocols and procedures currently used in control activities. For example, there are protocols associated with, i) legal minimum landing sizes to measure lengths; ii) the numbers of fish caught per unit time of towing (as used in the North Sea real time closures UK) and iii) the percentage of the total number of fish of a species that are under a reference sizes.

A switch to a RBM approach does present a number of challenges. The effectiveness of the approach is dependent on a high level of confidence. At sea monitoring will be required to ensure compliance. However, the compliance issue will affect vessels subject to different control regimes differently. Vessels subject to full documentation will be easier to control (and penalise) than vessels in the traditional control regime. There is a strong reliance at the individual level to incorporate technical measures voluntarily and that they use their knowledge to ensure compliance. There is a requirement for minimum standards to avoid so called “free-riders” undermining the efforts by innovative individuals. Vessel owners’ decisions on whether to change practices and if so, how much money it is worth spending, depend, in the absence of any positive incentive to change, on how likely they believe it there will be a negative consequence of not changing and how severe such a consequence would if they did change.

EWG-13-01 considers that the degree of faith in terms of monitoring and control will need to be considered when deciding whether there is a need for continued detailed technical measures. If a vessel owner believes that the sanction for failing to achieve the target levels is likely to be more costly than adopting measures to reduce unwanted catches, then, assuming the owner still expects to be profitable despite the additional cost, he will next consider how likely it is that his business will incur sanctions. If the sanctions are applied at fishery level, with no causal link to individual vessels, then each vessel owner must second-guess the actions of the other skippers in the fishery, some of whom are from different countries, in order to assess the probability that the fishery as a whole will achieve or miss the targets. This becomes essentially a prisoners’ dilemma situation. If a skipper chooses to adopt costly discard reduction practices, but not enough other skippers in the fleet do so and sanctions are applied, then the skipper who experienced the costs of compliance would also experience the costs of sanctions, whereas those who did not invest in discard reduction would suffer only the costs of sanctions. So the skipper who changes practices is penalised relative to those who did not improve their discard levels. Vessel owners may choose to reduce discards and hope to influence others to change practice such that the fishery overall achieves the discard level targets. Alternatively, they may expect that it is unlikely that others will change practices and will decide to accept the costs of the sanction only, rather than the costs of changing practices and the costs of sanctions as well. Therefore, if a sanction is to be effective, it must not only be more costly than changing practice to achieve the target, it must also apply specifically to vessels which do not achieve the discard targets, rather than equally to all vessels, whether or not they achieve the target.

Therefore, can the benefits of an RBM approach be retained in the absence of hard sanctions? There are currently catch-based results measures in place that are linked with real time closure systems. These were considered to incorporate a softer sanction whereby it is not vessel specific and requires all relevant vessels to cease fishing in a defined area for a defined period. This type of sanction system is likely to be better suited to a Catch-RBM and would reduce the level of incentive for non-compliance with a discard ban policy. An important benefit of the approach is in generating data that can be used to evaluate whether management objectives are being met. This data can be easily interpreted by fishers, managers and scientists alike. It could also be used to identify groups of vessels that require support in shifting their catch profiles. Another soft sanction could be mandatory requirement to participate in studies to improve selectivity with the target catch profile as the objective of the work. The move to a discard ban policy will require a fundamental shift in how fisheries are monitored, from a situation whereby fishing vessels are restricted in what can be retained onboard to one where they will be restricted in what can be discarded. This change will require new methods and approaches and will almost certainly include at-sea inspections. During at-sea inspections, assessing the catch profile from a haul/set and comparing it with the retained catches onboard will give an indication of compliance with the obligation to land all catches. Therefore, measurements that would be required to control a Catch-RBM approach would also be required to monitor compliance with a discard ban policy. In many instances the current measures are in contradiction with the proposed discard ban (e.g. minimum landings sizes, catch composition regulations), therefore if a Catch-RBM approach were developed and adopted it would avoid the requirement to reconstruct the current technical measures.

2.1.7. Industry considerations and responsibility

The Catch-RBM approach does have genuine benefits, for example it bridges the gap between catches on the deck with management targets for the stock and by doing so it is easy for stakeholders to see the aims of the measures. It also facilitates more flexibility to the fishermen in how they match their fishing operations with their quota allocations, and consequently reduces the need for prescriptive gear-based technical measures. A results-based approach of this type would mean fishermen would have the freedom to develop vessel specific technical solutions, which would not have to add further to the existing complex list of technical regulations.

Focusing on the composition or structure of catches is likely to increase the level in understanding of the regulation and its purpose by fishermen relative to current technical measures which can suffer from perverse incentives which lead to responses that are at odds with management objectives. EWG-12-14 noted that the current paternalistic approach incentivises innovation towards mitigating the potential or perceived impacts of technical measures. Under an RBM approach, where technical constraints are minimised or removed, fishermen would be encouraged to innovate and would have much higher flexibility in how they could alter the design of the fishing gear or modify their fishing strategies to achieve the desired catch profiles.

Assuming that control and enforcement problems can be solved then there would be a limited, if any, need for prescriptive regulations. The responsibility for introduction of measures would lie with the fishermen themselves. There may be different solutions to achieve a target. In many cases fishermen may have enough experience to be able to introduce the right measures. However, in cases it will be impossible for fishermen to assess the effects of the introduction of a certain measure. Therefore, there must be cooperation between scientists and the fishermen to find common solutions. It will also be helpful to perform a thorough impact assessment for certain measures at the beginning of a change to a RBM system to give managers and fishermen a better picture on the possible outcome.

A move towards a RBM approach, by default raises broader issues beyond simply technical regulations. The success of a RBM approach is also dependent on social (responsibility, management, tradition/ historical) and economic (labour, income) factors. This places onus on the industry to minimise unwanted catches i.e. focus on what they can sell and in some regards this means that the sector themselves become responsible for sustainable fisheries. However, before implementing a RBM it is important to consider that awareness, sense of accountability/responsibility and the common understanding of the fishery sector are important concepts that must be addressed. It must also be clear beforehand which results are expected, what are the time lines, what the biological and economic benefits are Implementation of an RBM approach needs to consider how individual fishermen are involved and what types of information are required to assist the transit from the current prescriptive approach.

The sector consists of numerous family-owned, rather small individual companies. Fishermen themselves generally seem not always very well informed and involved with policymaking issues.

They feel that others are responsible for solving problems about fish stocks and management of stocks and they refer to representatives of fishermen's interest who are now somehow involved with the process of making suggestions for necessary measures. Implementation of measures, will not say that the fishery sector will adopt them. The social process of acceptance is a very important and underestimated issue. A suggestion is to inform and organise fishermen that way that they become more involved with thinking about necessary measures to be taken so that they become more responsible for these measures too. It is important from a business perspective that any potential benefits from a stock perspective are also translated in economic terms e.g. potential increase in future revenue maybe helpful to inform fishermen. How 'significant' or tangible this may be at an individual level will be dependent on access rights within the fishery. However, this is closely linked to the concepts discussed in section 2.2.1, where the benefits of changes in exploitation pattern through tactical or technical adaptations (the means resting with the industry) would be seen as an important part of the process. There are now regular impact assessments required for the introduction of any new policy on EU level. Therefore, it can be part of the general implementation process of a new RBM plan to assess socio-economic impacts (short, mid and long-term trade-offs). This can be done also by comparing the effects of different measures possibly introduced by the fishing sector to achieve the targets. The results would then illustrate what may be the most cost effective way for the fishing sector to do that (see section 2.1.1 for a methodological explanation). It would create positive incentives for the fishing sector if the results show that in the mid to long run revenues increase.

2.1.8. Hybrid approaches

The above sections discuss the merits, considerations and disadvantages when shifting from a prescriptive to a result based approach. However, in practice these concepts do not have to be mutually exclusive and it is possible to have hybrid approaches. Lassen *et al*, 2008, identified a hierarchy of objectives and the appropriateness of the reversal of the burden of proof. High level principals, objectives and standards are the responsibility of governing bodies such as the EU or Regional Management Organisations. In the context of a more regional approach to the CFP where regional authorities and member states together with the industry have responsibility to achieve the overarching objectives, such bodies may choose to deploy prescriptive measures to attain specific goals or results.

Here we present an example of how prescriptive technical measures can support an overarching objective (the reduction of cod fishing mortality). There are often concerns that the framework within which these measures operate can be bureaucratic and slow; however, this does not necessarily have to be the case, particularly in the context of regionalisation where the regional authorities may have the ability to introduce such measures in an administrative rather than regulatory way. We demonstrate how metrics of output, even if they can be calculated at sufficiently high resolution, may be difficult to interpret. We also discuss the implementation of these measures and how fishermen's' support will depend on the flexibility of the scheme and ultimately the economic viability of their businesses.

The cod plan provides a provision for Member States to employ alternative measures as long as they delivered equivalent fishing mortality reductions to those specified in the management plan for cod stocks. In Scotland the Conservation Credits Scheme, an initiative involving industry, NGOs, scientists and government official, provides the framework for delivering a management process to achieve these targets. The national authorities committed to specified reductions in cod catches (overarching objective) allowing the industry, in cooperation with scientists, to develop the specific instruments to achieve the reductions. Two specific fisheries are considered, the gadoid fishery (TR1) and the *Nephrops* fishery (TR2).

This scheme is a combination of input and output controls.

Input controls

Demersal vessels targeting mixed demersal species (TR1) are granted a baseline number of days fishing for using the standard gear which in the Scottish demersal whitefish fishery (TR1 vessels) is a single or twin trawl with forward sections made of 120 – 160mm netting and with 120mm mesh size codends and extension sections. The gear options available include increasing codend mesh size, fitting a square mesh panel in the extension section, fitting large mesh size belly panels (behind the footrope) and increasing the mesh size of the whole of the forward section (the belly panel and all netting above and forward of it). These gears are categorised according to how selective they are for cod and their use is *incentivized* by offering additional days fishing according to which category they are in. The gear details, their category and the associated additional fishing days are detailed in Table 2.1.8.

TR2 vessels fishing in the Farne Deeps and the Fladen Grounds are *obliged* to use 'highly selective gears' which reduce the capture of cod by 60% in comparison to the standard prawn trawl fishing an 80mm codend with a 120mm SMP at 15 – 18m from the codline, with 60% target chosen by the administration. At present two gears have been developed by the Scottish fishing industry, the Flip–Flap trawl and the Faithlie Cod Avoidance Panel (FCAP) and have been accepted by STECF (PLEN 12-04) as fulfilling these requirements.

To implement these measures there was a need to define the specifications of the various gear options. The intention from the start was to try and keep these specifications as simple as possible yet provide enough detail so that the gears could be rigged and fished as intended. The design specifications are then detailed in the national conservation plan.

The design features of the TR1 gears (the Orkney/Shetland cod avoidance trawl) are very straightforward and simple definition which essentially specifies the mesh size and dimensions of the forward panels. To date these definitions have proved adequate in describing the gear for both operational and enforcement purposes, which may be attributable to the simplicity of the design modification and the robustness of the measure (insofar as small 'tweaking' is unlikely to significantly alter the selection characteristics)

The TR2 'highly selective gears' (FCAP) design features are more complicated, however. For these gears there was a greater need for detail due to the design changes being more innovative and the designs being less robust (small deviations from the design could lead to large changes of selectivity). The definitions of the TR2 gears also underwent a certain number of iterations as clarification was sought from either the fishing industry or the enforcement agency with regard to issues such as weak links, twine thickness, flotation, positioning of escape holes etc (the elements that had to be modified are in italics in the definition).Although this iterative process had the potential to be onerous and time consuming, it was not. Once the modified definition was agreed by the fishing industry and Marine Scotland, all that was required was an update and a reissue of the scheme rules. While the national cod management scheme has some degree of administrative and scientific burden, the process of introducing and adapting the gears permissible and the incentive structure used for the TR1 gears, is relatively straightforward and critically there is no complex legislative process. It could be envisaged that this would describe the approach that may be taken under regional based management plans.

Output controls

While the approach presented, demonstrates how national or regional plans can provide a great deal of flexibility in terms of how the industry can respond to specific targets, a related issue is how to demonstrate the efficacy of these types of measures. This is particularly difficult in this case where there are a number of different fleet segments, a number of gear options and the measures are part of a package which also includes the use of temporal and spatial closures. STECF (PLEN 11-04) noted that it is very difficult to disentangle the impact of multiple measures and that appropriate metrics that are sympathetic to the types of measures introduced are required. STECF (PLEN 10-02) noted that a comparison of catches pre and post introduction and a comparison of catch profiles associated with vessels within and outside the scheme would be useful. In the case of the TR2 example presented here, the latter option is not relevant as businesses are obliged to use the gear. Trends in CPUE could be considered as a metric of the fleet response. Figure 2.1.8.1 presents the cod cpue (kg per hour) on observed vessels in the Scottish TR1 fleet between 2008 and 2011. Although the observations are limited and cannot be treated as controlled comparisons, they are instructive as they highlight some of the difficulties associated with interpreting some of the output metrics. The results are counterintuitive and suggest that vessels that do not adapt any selective gears are in fact the most selective and equally that the 130 mm codend is more selective than the Orkney Gear, which is not backed up by results from supporting scientific trials.

The interpretation of this is difficult. It may reflect that those taking up the different options are vessels that already target cod leaving only those that primarily target other species in these categories. This may be particularly the case for the FDF boats which are generally acknowledged as being some of the main cod catching boats. Another possibility is that these vessels are transferring quota to other groups e.g. the FDF ones but then succeeding in avoiding cod so that their own catch rate declines.

These results also need to be seen in the light of the prevailing SSB (Fig. 2.1.8.2). The total cpue value for these data remains more or less constant suggesting that overall these measures have not been effective. Over the same time period, however, there has been an increase of SSB by about 40% indicating the converse and suggesting that indeed the selective gears have achieved their objective at least partially.

Fishermen's Understanding

Fishermen operating within the scheme are generally supportive of the developments; the reward of additional days at sea in return for reducing cod mortality in ways other than applying the effort-brake is seen as a positive move. There are economic negatives however that counter-balance and even outweigh the additional opportunity provided, especially for those that spend the least time at sea and benefit least of all from the additional effort provided. The loss of species such as anglerfish and megrim that flows from using the Flip-flap and FCAP often undermines the economic viability of the fishing business.

Many fishermen are also critical of the *one size fits all approach*, which assumes that every vessel is desperate for more days at sea and is willing to compromise efficiency to achieve it, when in reality a significant proportion of TR2 vessels were neither in need of more days at sea nor were they catching many cod, it is a negative sum game for these vessels because for this fleet segment (TR2), the use of the more selective gear was obligatory.

Nonetheless this system of input and output controls can be looked at a model for a regionalised approach and certainly has merits over the current EU top-down approach to technical measures. It has geared innovation in the right way and has instilled some sense of ownership on the fishermen involved in the fisheries.

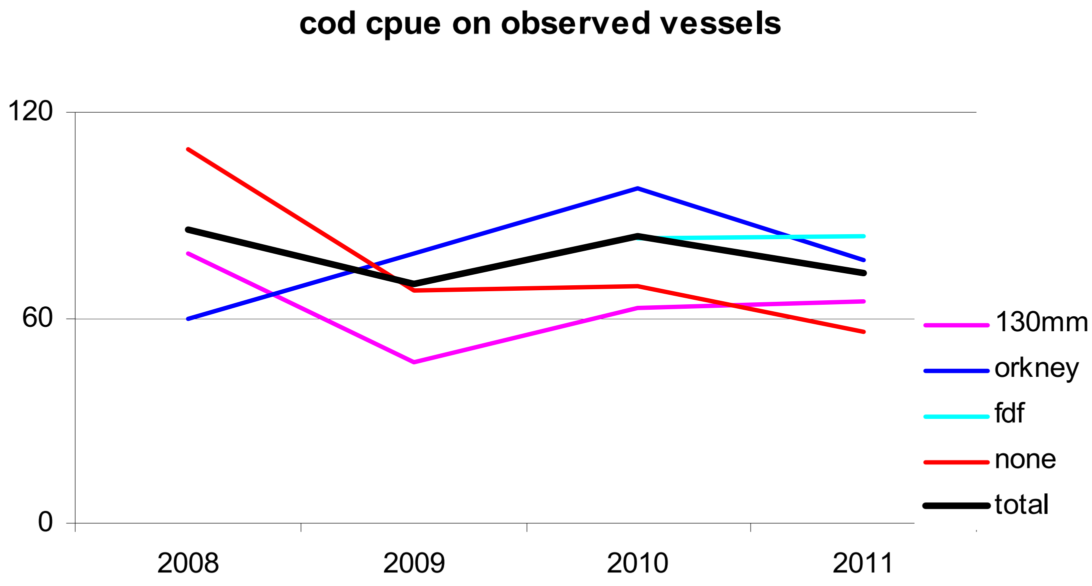

Figure 2.1.8.1. Cod cpue (kg per hour) on observed vessels in the Scottish TR1 fleet between 2008 and 2011

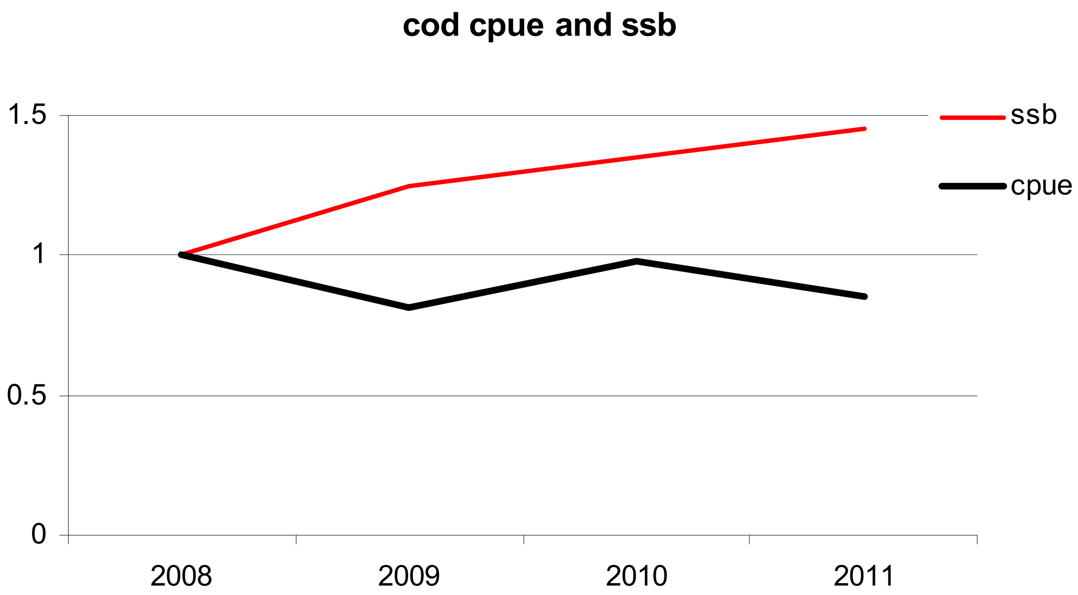

Figure 2.1.8.2 Trend in CPUE compared to increasing trend in SSB

Table 2.1.1.8 TR1 gear classifications and additional days at sea allocations.

		Allocations	
Classification	**Gears**	**Flat rate (days)**	**Track record**
Level 1 gear	• "130mm cod end"	+15	+8%
Level 2 gear	• "300mm belly mesh"	+30	+19%
Level 3 gear	• "Orkney trawl" • "Shetland trawl" • "200mm SMP" • "600mm belly mesh"	+50	+29%
Level 4 gear	• "Eliminator trawl" • "800mm belly mesh"	+70	+44%

3 CONCLUSIONS

- A move to a more regionalised management approach, incorporating mixed-fisheries management plans and an obligation to land all catches, will likely result in the need for the quantitative evaluation and role of technical measures (gear/spatial/temporal) in meeting mixed-fisheries obligations and minimizing TAC undershoots.
- Adjustments in exploitation pattern can result in changes in the MSY yield of a given stock through changes in Fmsy point estimates. Incorporating the effect of changing exploitation pattern in within regional management plans via harvest control rules may provide a transparent view on the potential impact that varying EP can have on fishing opportunities, thereby providing tangible incentives for adjusting selectivity. However, in the absence of catch based fishing opportunities, there will be little incentive in such an approach.
- Where different demographic groups (e.g. juveniles and adults) of a stock are targeted by different metiers, the full potential of managing exploitation pattern may not be realised and preference to regulating exploitation rate should be the norm.
- Highlighting the potential of changes in EP together with other management levers (e.g. TACs) in a structured requires further analysis and simulation. Consideration should be given to a much deeper iteration of this analysis based on different species and fisheries to establish the real effects and potential impacts.
- It could be expected that in fully documented fisheries, business are encouraged to minimise catches of length classes which have a lower price. Provided that the desired economic exploitation pattern is consistent with the optimum biological exploitation pattern, then it may not be necessary to specify the technical characteristics of the gears deployed. However, where there are broader ecosystem issues requiring protection through technical measures prescriptive measures will continue to be required.

- Similarly, the introduction of discard ban, where catches of unwanted or unmarketable fish are discounted from a vessels quota allocation, will provide an incentive to introduce technical and tactical responses to limit catches of with no market value. In principle at least, this should limit the need for technical measures towards broader ecosystem objectives.

- De-regulating the need for specific technical measures will, in principal, remove the need for specifying minimum mesh sizes. As mesh size bands are currently used to define 'fleet' management units e.g. Cod plan, and sampling units e.g. DCF level 6, alternative metrics would be required for these definitions if required.

- The degree of faith in overall compliance of a discard ban is crucial. If the level of monitoring and control is considered insufficient, then prescriptive based technical measures will continue to be required. Failure to introduce adequate safety into the system when there are concerns about the degree of control could potentially have significant and negative consequences. As such there will be a continued requirement for minimum standards to avoid so called "free-riders" undermining the efforts by innovative and compliant individuals.

- Results based approaches or approaches where there are clearly defined objectives such as prescribed reductions in fishing mortality or catch rates, can provide appropriate and clear targets. In the context of regional or national management plans, there is evidence to date that shows that such an approach has achieved positive directional change.

- In principle, catch based indicators as a 'result-metrics' could be seen as an alternative to prescriptive technical specifications of fishing gears. This has the advantage of providing a closer link to the objective in terms of attaining a specific catch profile rather than using the technical characteristics of the gear as a proxy. The proposed Conservation Reference Size could be used as such and indicator provided that the reference sizes are linked to the objective of obtaining a specific catch profile. A catch based approach is also dependent on the escape survival of individual species and age groups and where modifications proposed result in elevated escape mortality, the perceived sustainability objectives may not be met.

- Implementation of this system might lead to an incentive towards non compliance with the objectives of the discard ban**.** A limit on catch percentage of small (or undesirable) fish may result in unintended negative consequences that counteract the intentions behind the discard ban.

- The choice of indicators is important as catch based parameters are not only influenced by the choice of selectivity measure and tactic, but also on the underlying population structure making it difficult to disentangle the technical/tactical effects from changes in the population. This can result in unstable indicators and indicators that are not solely responsive to the technical/tactical changes by individual businesses. Choice of indicator is likely to be fishery and regionally specific and are likely to require continued revaluation.

- Catch based indicators provide guidance on the exploitation pattern at an individual business level and if minimum standards are maintained/required, catch based indicators can be used to encourage improvements in selection patterns as it provides a readily understood and obvious relationship between the overarching objective and the catch. Such catch based indicators are already used in the North Sea as a means of and are used as the basis of soft sanctions e.g. enacting area closures or moving on procedures.

- Setting minimum selectivity standards may pose an alternative approach to the use of pure catch based metrics. However, this would require ongoing scientific evaluation of gears proposed by industry to meet the targets and would likely result in defining a list of permissible gears due to control and enforcement concerns.

- In terms of broader ecosystem objectives, it is likely that there will be an ongoing requirement for prescriptive measures to ensure that broader ecosystem objectives e.g. minimisation of benthic impact are achieved. It is noted that even under a results based approach focussed on achieving specific exploitation patterns, it is likely that the technical and operational tactics deployed are also likely to result in reductions in unwanted ecosystem impacts e.g. reduction in the catches of unwanted fish for example.

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6 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg1301

List of background documents:

1. EWG-13-01 – Doc 1 - Declarations of interests (see also section 5 of this report – List of participants)

European Commission

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STECF members: Casey, J., Abella, J. A., Andersen, J., Bailey, N., Bertignac, M., Cardinale, M., Curtis, H., Daskalov, G., Delaney, A., Döring, R., Garcia Rodriguez, M., Gascuel, D., Graham, N., Gustavsson, T., Jennings, S., Kenny, A., Kirkegaard, E., Kraak, S., Kuikka, S., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Nowakowski, P., Prellezo, R., Sala, A., Scarcella, G., Simmonds, J., Somarakis, S., Stransky, C., Theret, F., Ulrich, C., Vanhee, W. & Van Oostenbrugge, H.

EWG-13-01 members: Graham, N., Abella, J. A., Döring, R., Kraak, S., Sala, A., Catchpole, T., Dransfeld, L., Kelly, C., Kennedy, L., Larnaud, P., MacMullen, P., McDonald, D., Minto, C., O'Neill, B., Taal, K., Valentinsson, D., Van Helmond, E. & Vasilakopoulos, P.

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Abstract

The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 13-01 was held from 4 – 8 March 2013 in Dublin, Ireland, to continue the work of EWG 12-14 aiming to explore the salient issues surrounding technical measures. The report was reviewed by the STECF during its 42nd plenary held from 8 to 12 April 2013 in Brussels (Belgium).

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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